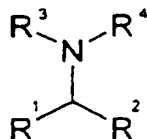


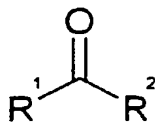
Claims

1. A process for preparing amines of the formula (III)



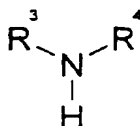
(III)

by reacting a compound of the formula (I)



(I)

with a compound of the formula (II)



(II)

where the radicals

R^1 to R^4 are selected independently from the group consisting of hydrogen, (C₁-C₂₄)-alkyl, (C₂-C₂₄)-alkenyl, (C₂-C₂₄)-alkynyl, (C₆-C₁₀)-aryl, CF₃, CN, COOH, COOM, where M is a cation selected from the group consisting of Li⁺, Na⁺, K⁺, Mg²⁺, Ca²⁺, NH₄⁺, N(C₁-C₁₀-alkyl)₄⁺, N(C₁-C₁₀-alkyl/C₆-C₁₀-aryl)₄⁺, CHO, SO₃H, COO-alkyl-(C₁-C₈), CONH₂, CONHalkyl-(C₁-C₈), CONalkyl₂-(C₁-C₈), CO-alkyl-(C₁-C₈), CO-phenyl, COO-phenyl, COO-aryl-(C₆-C₁₀), CO-aryl-(C₆-C₁₀), P(aryl)₂, Palkyl₂-(C₁-C₈), PO(aryl)₂, POalkyl₂-(C₁-C₄), PO₃H₂, POalkyl-(C₁-C₄)(O-alkyl-(C₁-C₆)), PO(O-

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alkyl-(C₁-C₈))₂, SO₃-alkyl-(C₁-C₄), SO₂-alkyl-(C₁-C₆), SO-alkyl-(C₁-C₆) or Si(alkyl)₃-(C₁-C₈), and/or R³ and R⁴ are selected independently from the group consisting of O-alkyl-(C₁-C₈), OCO-alkyl-(C₁-C₈), O-aryl, fluorine, OH, NH₂, NH-alkyl-(C₁-C₈), N-alkyl₂-(C₁-C₈), NHCO-alkyl-(C₁-C₄), NHCOO-alkyl-(C₁-C₄), NHaryl-(C₆-C₁₀),

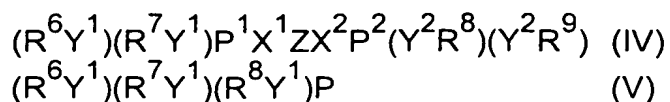
where alkyl is, for the purposes of the present invention, an unbranched or branched aliphatic or cyclic radical, where from one to four carbon atoms of the alkyl radical may be replaced by nitrogen, sulfur or oxygen atoms, alkenyl is an olefinic hydrocarbon, alkynyl is an acetylenic hydrocarbon and aryl is an aromatic radical, where from one to four carbon atoms of the aromatic radical may be replaced by nitrogen, sulfur or oxygen atoms,

alkyl, alkenyl, alkynyl and also aryl may bear substituents selected independently from among hydrogen, O-alkyl-(C₁-C₈), OCO-alkyl-(C₁-C₈), O-phenyl, phenyl, aryl(C₆-C₁₀), fluorine, chlorine, bromine, iodine, OH, NO₂, CF₃, CN, COOH, COOM, where M is a cation selected from the group consisting of Li⁺, Na⁺, K⁺, Mg²⁺, Ca²⁺, NH₄⁺, N(C₁-C₁₀-alkyl)₄⁺, N(C₁-C₁₀-alkyl/C₆-C₁₀-aryl)₄⁺, CHO, SO₃H, NH₂, NH-alkyl-(C₁-C₈), N-alkyl₂-(C₁-C₈), NHCO-alkyl-(C₁-C₄), COO-alkyl-(C₁-C₈), CONH₂, CO-alkyl-(C₁-C₈), NHCOH, NHCOO-alkyl-(C₁-C₄), CO-phenyl, COO-phenyl, COO-aryl-(C₆-C₁₀), CO-aryl-(C₆-C₁₀), CHCH-CO₂-alkyl-(C₁-C₈), P(aryl)₂, CHCHCO₂H, P-alkyl₂-(C₁-C₈), PO-aryl₂, POalkyl₂-(C₁-C₄), PO₃H₂, POalkyl-(C₁-C₄)(O-alkyl-(C₁-C₆)), PO(O-alkyl-(C₁-C₆))₂, SO₃-alkyl-(C₁-C₄), SO₂-alkyl-(C₁-C₆), SO-alkyl-(C₁-C₆) or Si(alkyl)₃-(C₁-C₈).

both R¹ and R² and also R³ and R⁴ can be linked by covalent bonds so that R¹ and R² and/or R³ and R⁴ in each case form a four- to eight-membered ring, where R¹ or R² may also be part of an organometallic compound,

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10 R^6 to R^9

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 x^1 and x^2 R^{10}

and where two of these substituents may also be bridged, are each, independently of one another, a direct phosphorus-carbon bond, O, S or NR¹⁰, where corresponds to one of the radicals defined for R⁶-R⁹,

Y^1 and Y^2 is a direct phosphorus-carbon bond, $-O-$ or $-NR^{11}$, where
 R^{11} corresponds to one of the radicals defined for R^6-R^9 ,
 Z corresponds to 1-6 carbon atoms which are bound to one
 another by single or multiple bonds and connect the unit
 5 $(R^6Y^1)(R^7Y^1)PX^1$ to the unit $X^2P(Y^2R^8)(Y^2R^9)$, where Z may
 be part of an aliphatic, cycloaliphatic, olefinic, cycloolefinic
 system which may contain from one to four heteroatoms from
 the group consisting of N, O, S, a metallocene, in particular a
 ferrocene, a 1,1'-disubstituted ferrocene, 1-(1-ethylenyl)-2-
 10 ferrocenyl or a 1,2-disubstituted ferrocene, or one or more
 aromatic or heteroaromatic ring systems, where the ring
 system comprises a total of from 2 to 14 carbon atoms which
 may be monosubstituted or polysubstituted by substituents as
 specified for R^6-R^9 or directly by C_1 - C_{10} -alkoxy, OCO-alkyl-
 15 (C_1-C_8) , O-aryl- (C_5-C_{10}) , O-phenyl, C_1 - C_9 -trihalomethylalkyl,
 trifluoromethyl, trichloromethyl, fluoro, chloro, bromo, iodo,
 nitro, hydroxy, trifluoromethylsulfonato, oxo, thio, thiolato,
 amino, C_1 - C_8 -substituted amino of the formulae NH_2 , NH -
 alkyl- C_1-C_8 , NH -aryl- C_5-C_6 , N -alkyl $_2$ - C_1-C_8 , N -aryl $_2$ - C_5-C_6 ,
 20 N -alkyl $_3$ - $C_1-C_8^+$, N -aryl $_2$ - C_5-C_6 -aryl- $C_5-C_6^+$, C_1 - C_6 -acyloxy,
 carboxylato of the formulae $COOH$ and $COOR^{12}$, sulfinato,
 sulfonato of the formulae SO_3H and SO_3R^{12} , phosphonato
 of the formulae PO_3H_2 , PO_3HR^{12} and $PO_3R^{12}_2$, where R^{12} is
 either a monovalent cation, NH_4^+ , $N(C_1-C_{10}\text{-alkyl})_4^+$,
 25 $N(C_1-C_{10}\text{-alkyl}/C_6-C_{10}\text{-aryl})_4^+$, C_1 - C_8 -alkyl or C_6 -aryl, C_1 - C_6 -
 trialkylsilyl, $NHCO$ -alkyl- (C_1-C_4) , COO -alkyl- (C_1-C_8) , $CONH_2$,
 $CON(alkyl-(C_1-C_8))_2$, CO -alkyl- (C_1-C_8) , CO -alkenyl- (C_1-C_8) ,
 $NHCOO$ -alkyl- (C_1-C_4) , CO -aryl- (C_6-C_{10}) , CO -phenyl, COO -
 aryl- (C_6-C_{10}) , COO -phenyl, $CHCH-CO_2$ -alkyl- (C_1-C_8) ,
 30 $CHCHCO_2H$, and
 P is a trivalent phosphorus atom.

2. The process as claimed in claim 1, wherein bidentate ligands of the
 formula (IV) in which R^6 to R^9 are, independently of one another,
 35 C_1 - C_8 -alkyl, C_5 - C_6 -cycloalkyl, C_6 -aryl, C_4 - C_5 -heteroaryl, where the
 number of heteroatoms is 1-2, selected from the group consisting of
 N, O, S, and the ring size is 5-6, or are naphthyl, with these groups
 being able to bear one or more substituents, preferably

substituents selected independently from among hydrogen, C₁-C₁₀-alkyl, C₁-C₆-haloalkyl, C₅-C₆-cycloalkyl, C₂-C₉-heterocycloalkyl, C₆-aryl, phenyl, C₄-C₅-heteroaryl, where the number of heteroatoms from the group consisting of N, O, S, can be 1-2, C₁-C₆-alkoxy, OCO-alkyl-(C₁-C₆), O-aryl-C₆, C₁-C₆-trihalomethylalkyl, fluoro, chloro, bromo, iodo, nitro, hydroxy, oxo, thio, thiolato, amino, C₁-C₈-substituted amino of the types mono-, di-, tri-C₁-C₈-alkylamino or C₂-C₈-alkenylamino or mono- and di-C₆-C₈-arylamino or C₁-C₈-alkyl-C₆-C₈-arylamino, NH-CO-alkyl-C₁-C₈, NH-CO-aryl-C₆-C₈, C₁-C₈-acyloxy, carboxyl, carboxylato of the formula COOR¹², sulfinato, sulfonato of the formula SO₃R¹², phosphonato of the formula PO₃H₂, PO₃HR¹², PO₃R¹²₂, where R¹² is either a monovalent or divalent cation (Li⁺, Na⁺, K⁺, Mg²⁺, Ca²⁺), NH₄⁺, N(C₁-C₁₀-alkyl)₄⁺, N(C₁-C₁₀-alkyl/C₆-C₁₀-aryl)₄⁺, C₁-C₈-alkyl or C₆-aryl, and tri-C₁-C₆-alkylsilyl, are used.

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3. The process as claimed in either of the preceding claims, wherein R⁶ to R⁹ are selected independently from the group consisting of (C₃-C₈)-alkyl, (C₆-C₁₀)-aryl, O-(C₅-C₈)-alkyl, O-(C₆-C₁₀)-aryl or an aliphatic or aromatic (C₃-C₉)-heterocycle containing from 1 to 4 nitrogen atoms.
4. The process as claimed in any of the preceding claims, wherein R⁶ and R⁷ and/or R⁸ and R⁹ may be linked by a covalent bond so as to form a cyclic compound having from four to eight atoms.
5. The process as claimed in claim 1 or 2, wherein ligands in which Y¹ and Y² are each a direct phosphorus-carbon bond are used.
6. The process as claimed in any of the preceding claims, wherein Z comprises from one to four carbon atoms, in particular two carbon atoms.
7. The process as claimed in any of the preceding claims, wherein Z is a C₁-C₆-alkyl or C₂-C₆-alkenyl group or is part of a C₃-C₈-cycloalkyl, C₅-C₈-cycloalkenyl, C₂-C₉-heterocycloalkyl, C₁-C₉-heterocycloalkenyl, C₆-C₁₄-aryl, phenyl, naphthyl, fluorenyl or C₂-C₁₃-heteroaryl group, where the number of heteroatoms from the

Alc.

group consisting of N, O, S can be 1-4 and all these groups may be monosubstituted or polysubstituted as described in claim 1.

8. The process as claimed in any of the preceding claims, wherein ligands in which a three- to nine-membered ring system can be formed by Z, X¹, X², P¹ and P² together with a coordinated metal are used.

9. The process as claimed in claim 1, wherein 1,4-bis(diphenylphosphino)butane, 1,4-bis(dicyclohexylphosphino)butane, 2-diphenylphosphinomethyl-4-diphenylphosphino-1-tert-butoxycarbonylpyrrolidine, 2,3-O-isopropylidene-2,3-dihydroxy-1,4-bis(diphenylphosphino)butane, (2R,3R,5R,6R)-2,3-dimethoxy-2,3-dimethyl-5,6-bis(diphenylphosphinomethyl)-1,4-dioxane, tris-(3-sulfophenyl)phosphine trisodium salt, 2,2'-bis[[bis(3-sulfophenyl)phosphino]methyl]-4,4',7,7'-tetrasulfo-1,1'-binaphthyl octasodium salt, diphosphinite ligands based on carbohydrates, 1,2-bis(diphenylphosphinoxy)ethane, (1R,2R)-(trans)-1,2-bis-(diphenylphosphinoxy)cyclohexane, (2R)-1-[[bis(diphenylphosphino)(cyclopentyl)amino]methyl]-2-diphenylphosphinoxy-3-(1-naphthalenyl-oxy)propane and/or (4S)-2-(2-(diphenylphosphino)phenyl)-4-isopropyl-1,3-oxazoline are used as ligands.

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10. The process as claimed in any of the preceding claims, wherein the starting materials of the formulae (I) and/or (II) used are ones whose substituents R¹ to R⁴ are each, independently of one another, hydrogen, (C₁-C₁₂)-alkyl, (C₂-C₁₂)-alkenyl, (C₂-C₁₂)-alkynyl, (C₆-C₁₀)-aryl, CF₃, CN, COOH, COOM, where M is a cation selected from the group consisting of Li⁺, Na⁺, K⁺, Mg²⁺, Ca²⁺, NH₄⁺, N(C₁-C₁₀-alkyl)₄⁺, N(C₁-C₁₀-alkyl/C₆-C₁₀-aryl)₄⁺, COO-alkyl-(C₁-C₈), CONH₂, CONHalkyl-(C₁-C₈), CONalkyl₂-(C₁-C₈), CO-alkyl-(C₁-C₈), CO-phenyl, COO-phenyl, COO-aryl-(C₆-C₁₀), CO-aryl-(C₆-C₁₀), PO(aryl-C₆-C₁₀)₂, POalkyl₂-(C₁-C₄), PO₃H₂, PO(alkyl-(C₁-C₄))(Oalkyl-(C₁-C₄)), PO(O-alkyl-(C₁-C₆))₂ or Si(alkyl)₃-(C₁-C₈) and/or R³ and R⁴ are selected independently from the group consisting of O-alkyl-(C₁-C₈), OCO-alkyl-(C₁-C₈), O-aryl(C₆-C₁₀), OH, NH₂, NH-alkyl-(C₁-C₈), N-alkyl₂-(C₁-C₈), NHCO-alkyl-(C₁-C₄), NHCOO-alkyl-(C₁-C₄), NHaryl-(C₆-C₁₀), where alkyl is

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an unbranched or branched aliphatic or cyclic or heterocyclic radical containing from one to four heteroatoms selected from the group consisting of N, O, alkenyl is an olefinic hydrocarbon, alkynyl is an acetylenic hydrocarbon and aryl is an aromatic radical which may also be an aromatic containing 1-4 heteroatoms from the group consisting of N, O and S.

and alkyl, alkenyl and alkynyl and also aryl may bear substituents selected independently from among hydrogen, O-alkyl-(C₁-C₈), OCO-alkyl-(C₁-C₈), O-phenyl, phenyl, aryl-C₆-C₁₀, fluorine, chlorine, bromine, iodine, OH, NO₂, Si-alkyl₃-(C₁-C₈), CF₃, CN, COOH, COOM, where M is a monovalent cation selected from the group consisting of Na, K, Rb, Cs, NH₄, N(C₁-C₁₀-alkyl)₄, N(C₁-C₁₀-alkyl/C₆-C₁₀-aryl)₄, and SO₃H, N-alkyl₂-(C₁-C₈), SO₂-alkyl-(C₁-C₆), SO-alkyl-(C₁-C₆), NHCO-alkyl-(C₁-C₄), COO-alkyl-(C₁-C₈), CONH₂, CO-alkyl-(C₁-C₈), CO-phenyl, COO-phenyl, COO-aryl-(C₆-C₁₀), CO-aryl-(C₆-C₁₀), PO-phenyl₂, POalkyl₂-(C₁-C₄), PO₃H₂, POalkyl-(C₁-C₄)(O-alkyl-(C₁-C₆)), PO(O-alkyl-(C₁-C₆))₂, Si(alkyl)₃-(C₁-C₈), where alkyl and aryl are as defined above.

11. The process as claimed in any of the preceding claims, wherein the starting materials of the formulae (I) and/or (II) used are ones in which R¹ and R² and/or R³ and R⁴ are linked by covalent bonds so as to form a three- to nine-membered ring.

12. The process as claimed in any of the preceding claims, wherein metal complexes having central atoms selected from the group consisting of Rh, Ru, Ir, Pd, Pt, Ni, in particular ones containing rhodium as central atom, are used as homogeneous metal atom-ligand complex.

13. The process as claimed in any of the preceding claims, wherein alkyl is an unbranched or branched aliphatic or cyclic hydrocarbon and aryl is an aromatic radical.

14. The process as claimed in claim 13, wherein both alkyl and aryl bear substituents selected independently from among hydrogen, O-alkyl-(C₁-C₈), O-phenyl, phenyl, aryl, fluorine, chlorine, OH, NO₂, Si-alkyl₃-(C₁-C₄), CF₃, CN, SO₃H, N-alkyl₂-(C₁-C₄), CO-phenyl, COO-

phenyl, COO-aryl-(C₆-C₁₀), CO-aryl-(C₆-C₁₀), PO-phenyl₂, PO-alkyl₂-(C₁-C₄), PO(O-alkyl(C₁-C₆))₂, Si((alkyl)₃-(C₁-C₈)), where alkyl and aryl are as defined above.

- 15 15. The process as claimed in any of the preceding claims which is carried out at a temperature of -40-100°C.
16. The process as claimed in any of the preceding claims in which further additives are used.
- 10 17. The process as claimed in claim 16 carried out using phosphine-rhodium complexes in the presence of acids.
- 15 18. The process as claimed in any of claims 1 to 15 carried out using phosphinite-rhodium catalysts without the addition of additives.
19. The process as claimed in any of the preceding claims, wherein solvents used are alcohols, water, halogenated hydrocarbons, ethers, aromatic hydrocarbons and mixtures thereof.
- 20 20. The process as claimed in any of the preceding claims, wherein the initial hydrogen pressure is from 0.1 to 300 bar.
- 25 21. The process as claimed in any of the preceding claims, wherein the catalyst system is used in an amount of from 0.001 to 5 mol%, based on the carbonyl component of the formula (I).